Constructing stem cell microenvironments using bioengineering approaches.

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Public Summary:
Within the adult organism, stem cell reside in defined anatomical microenvironnments called niches. These architecturally diverse microenvironments serve to balance stem cell self-renewal and differentiation. Proper regulation of this balance is instrumental to tissue repair and homeostasis, and any imbalance can potentially lead to diseases such as cancer. Within each of these microenvironments, a myriad of chemical and physical stimuli interact in a complex (synergistic or antagonistic) manner to tightly regulate stem cell fate. The in vitro replication of these in vivo microenvironments will be necessary for the application of stem cells for disease modeling, drug discovery, and regenerative medicine purposes. However, traditional reductionist approaches have only led to the generation of cell culture methods that poorly recapitulate the in vivo microenvironment. To that end, novel engineering and systems biology approaches have allowed for the investigation of the biological and mechanical stimuli that govern stem cell fate. In this review, the application of these technologies for the dissection of stem cell microenvironments will be analyzed. Moreover, the use of these engineering approaches to construct in vitro stem cell microenvironments that precisely control stem cell fate and function will be reviewed. Finally, the emerging trend of using high-throughput, combinatorial methods for the stepwise engineering of stem cell microenvironments will be explored.

Scientific Abstract:
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